MULTIMEDIA UNIVERSITY ™

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, SESSION 2022/2023 (TERM ID 2220)

EEL1016 – ENERGY CONVERSION 1

(LE)

7 JULY 2023
9 a.m – 11 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question Paper consists of 5 pages including the cover page with FOUR Questions only.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

QUESTION 1

(a) Explain the reason for the following statements in a power system:

(i) Delta-connected load is more common compared to the star-connected load. [2 marks]

(ii) Wye-connected sources are more common in practice. [3 marks]

(b) **Figure Q1(b)** shows a balanced three-phase system with delta-connected load of $(210 + j120)\ \Omega$. Assume **positive sequence** and that the **phase to neutral voltage** at the generator is the **angle reference**.

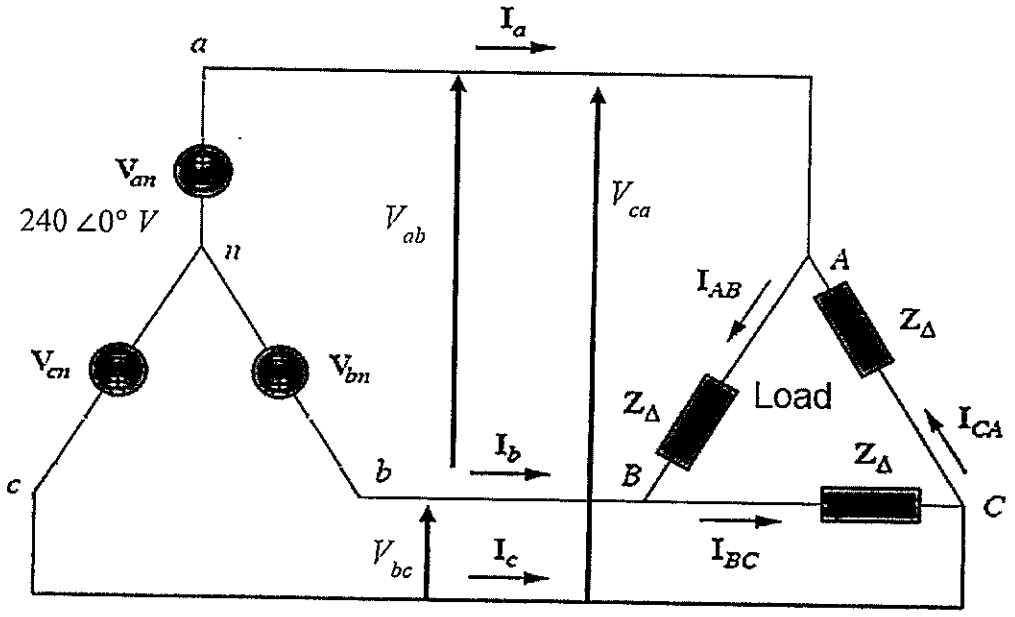

Figure Q1(b)

(i) Transform the $\boldsymbol{Z}_\Delta$ load to wye-connected load ($\boldsymbol{Z}_Y$), and hence redraw the Y-Y network after the transformation. [2 + 3 marks]

(ii) Draw the phase–a equivalent circuit by clearly identify the numerical values of the source voltage (V_{an}) and per-phase impedance of the load. [3 marks]

(iii) Based on the per-phase circuit obtained in Part (ii), calculate the phase currents of the system. [4 marks]

(iv) Compute the three-phase complex power consumed by the load. [2 marks]

(v) Calculate the power factor of the system. [3 marks]

(vi) Draw the phasor diagram of the phase-a currents. [3 marks]

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QUESTION 2

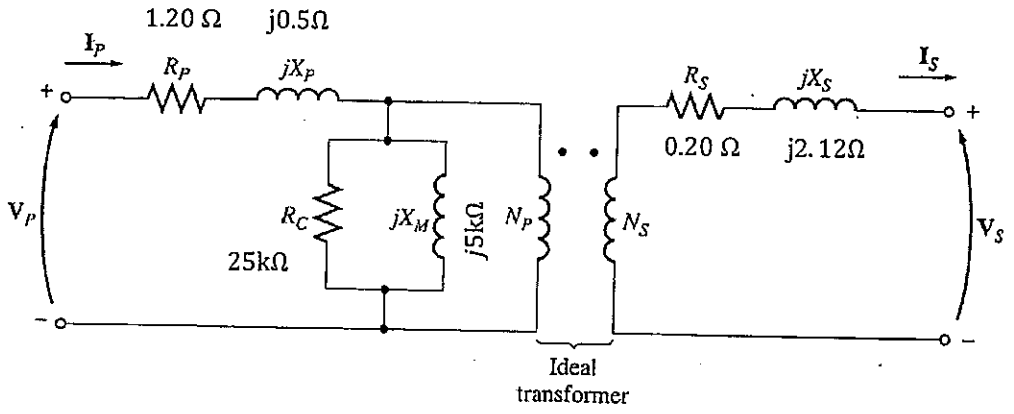

Figure Q2

Figure Q2 shows a 75 kVA, 7200/480 V, 50Hz, single-phase transformer equivalent circuit.

(a) Determine the transformer ratio, a. [2 marks]

(b) Draw the transformer equivalent circuit after impedance transformation from **primary to secondary**. The circuit parameters need to be labelled clearly. [8 marks]

(c) **Table Q2(c)** shows the open-circuit and short circuit test for a 1500 VA, 240/115 V single-phase transformer.

Table Q2(c)

Measurement	Short Circuit Test	Open Circuit Test
Voltage (V)	14.5	240
Current (A)	6.68	0.5
Power (W)	25	42

(i) From the given test data, determine the location of the test being conducted. That is, whether it was conducted at the low- or high-voltage side. [3 marks]

(ii) Based on the test results, calculate R_C, X_M, R_{eq} and X_{eq}. [7 marks]

(iii) Determine the efficiency of the transformer at the rated condition and at 0.85 *pf* lagging. [5 marks]

Continued .....

QUESTION 3

(a) Compare the features listed in the following table for wound rotor and squirrel cage type of induction motors:

Feature	Wound rotor	squirrel cage
Efficiency		
Construction		
Cost		
starting torque		

[5 marks]

(b) **Figure Q3(b)** shows the power flow diagram of a 6-pole, 380V, 3-phase induction motor with a full load output of 30 kW. The motor is operated at 0.88 *pf* lagging with system frequency of 60 Hz and the efficiency of 80%. Given the slip of the motor is 0.05 and the motor full load stator copper losses are 2.1 kW.

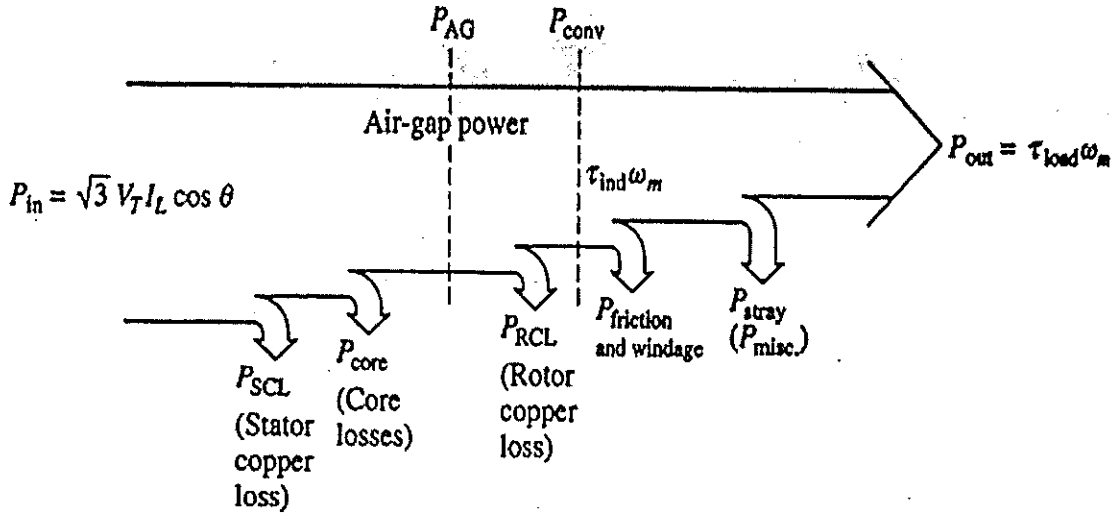

Figure Q3(b)

(i) Sketch the per-phase equivalent circuit of the motor based on the power flow shown in **Figure Q3(b)**. [5 marks]

(ii) Calculate the motor speed. [3 marks]

(iii) Find the line current. [5 marks]

(iv) Determine the rotor copper loss. [4 marks]

(v) Calculate the rotational loss. [3 marks]

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QUESTION 5

(a) Name the two types of commonly used windings for synchronous machines. [2 marks]

(b) Assume the rotor for the machines is non-salient pole type, state the factors that cause the difference between the terminal voltage and the internal generated voltage produced in the synchronous machines. [3 marks]

(c) A 3-phase, 4-pole, 4kVA, 220V, 50Hz, star-connected synchronous generator has negligible stator winding resistance and a synchronous reactance of 12 Ω per phase at rated terminal voltage.

(i) Sketch and label the per-phase equivalent circuit for the synchronous generator. [3 marks]

(ii) Determine the excitation voltage and the power angle of the synchronous generator if it is delivering rated kVA at 0.8 power factor lagging. [9 marks]

(d) A 3-phase, star-connected alternator rated at 1350 kVA, 15500 V is operated at power factor of 0.8 lagging. The per phase armature effective resistance and synchronous reactance are 1.25 ohms and 30 ohms, respectively.

(i) Calculate the armature current, I_A. [2 marks]

(ii) Find the terminal voltage. [1 mark]

(iii) Determine the internal generated voltage, E_A. [3 marks]

(iv) Calculate the percentage regulation for a load of 1420 kW at power factor of 0.8 lagging. [2 marks]

End of Paper.